INTERPRETING BROKEN ARROW POINTS

William Engelbrecht

This paper compares unnotched triangular arrow point refits (conjoined fragments) with whole points from the Eaton site in New York. The differences between the two samples are significant, suggesting that point typologies based on whole points may be misleading. Refits tended to have greater length to width ratios and lower thickness to length ratios, rendering them less durable. While lack of durability is generally considered to be a negative characteristic of stone points, fragmentation of a projectile in an enemy or hunting prey creates a large internal wound cavity, which is desirable. Also desirable is a point base that makes a cut wide enough to prevent drag on the arrow shaft, but narrow enough to have a good chance of passing through the ribs of the target.

En este trabajo se comparan las puntas de proyectil re-ensambladas (fragmentos que remontan) con las puntas enteras procedentes del sitio Eaton, New York. Los resultados muestran que las diferencias entre las dos muestras son significativas, lo cual sugiere que las tipologías basadas en puntas enteras pueden ser engañosas. Las puntas re-ensambladas suelen tener mayores proporciones de longitud y anchura y menores proporciones de longitud y espesor lo cual les hace menos duraderos. En general se considera una característica negativa la falta de durabilidad de las puntas, sin embargo la fragmentación de un proyectil dentro del cuerpo de un enemigo o de la carne de la presa crea una gran herida en la cavidad interna lo cual es deseable. Otra característica esperable es que la base de las puntas realicen un corte lo suficientemente ancho como para prevenir o evitar la fricción en el asta de la flecha, pero asimismo suficientemente estrecho para que tenga una buena probablidad de pasar por las costillas del blanco.

Madison points are thin, unnotched triangular arrow points with a wide distribution over eastern North America and the Midwest (Justice 1987:224-227; Ritchie 1971:33-34). A total of 516 whole Madison points, 692 point tips, 129 point mid-sections, and 893 point bases were recovered from the Eaton site in western New York (see Figure 1). A point refit study resulted in 114 fragment matches, providing a unique opportunity to compare whole points with point refits. The comparison revealed that at Eaton, point refits differ significantly from whole points. The reasons for this difference and for point breakage are considered in this article.

In New York, the first unnotched arrow points were Levanna points (Ritchie 1971:31-33). These large equilateral points were gradually replaced by smaller isosceles Madison points. This shift is mirrored in a trend of decreasing arrow point width, weight, and thickness across the Eastern Woodlands (Blitz and Porth 2013:89-90). Hughes (1998) and Lyman et al. (2008) suggest that arrow points likely evolved increasingly effective performance characteristics, but to date these characteristics have not been identified. Since Madison points were used for both hunting and warfare, their design must be considered in light of how effectively they could kill both deer and enemies. The pattern of point breakage at Eaton is suggestive of the selective pressures influencing the evolution of point design.

Eaton (Buf 2-4, A029-25-0003) is a multicomponent site with an Iroquoian component comprised of a palisaded village dating to around A.D. 1550 with longhouses and an estimated population of 445 people (Engelbrecht 2014a). Like other Iroquoian villages of its approximate size and date, it is believed to have been occupied for be-

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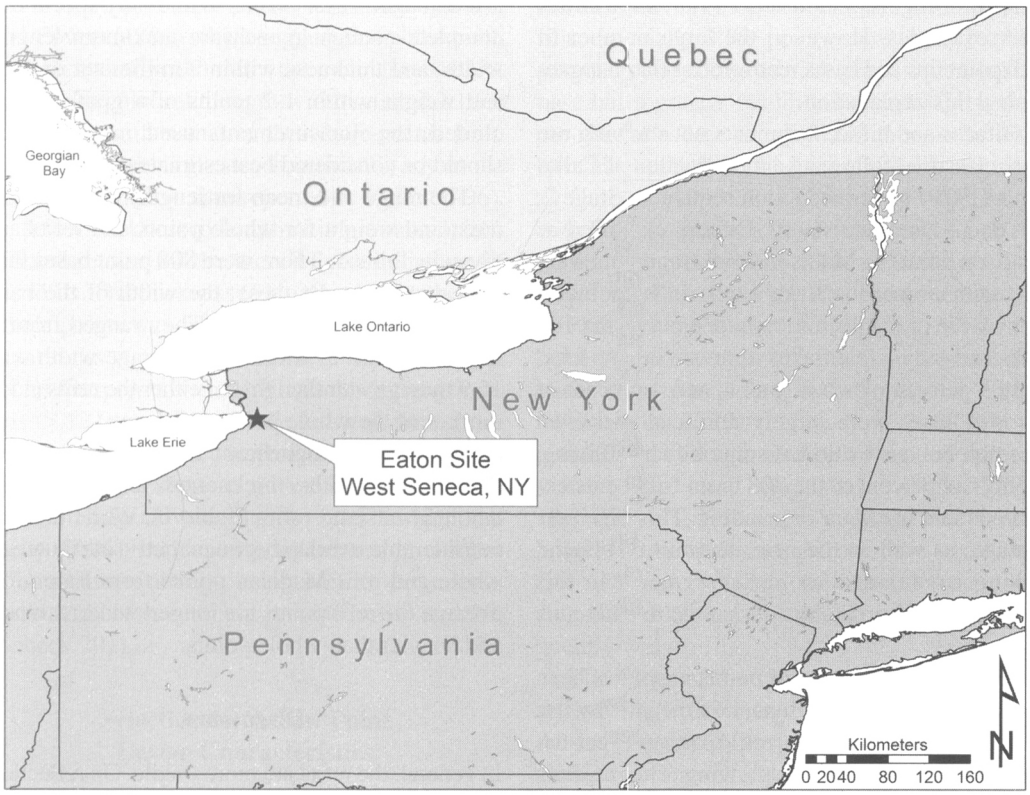


Figure 1. Location of the Eaton site.

tween 10 and 20 years (Engelbrecht 2003:101-104). The points considered in this study are all Madison points and all likely date to the village occupation.

In an earlier study I argued that the large number of unnotched triangular points on many village sites were the consequence of having been brought back to the village in game (Engelbrecht 2014a). They were likely hafted in such a way that they detached readily from the arrow shaft once in their target, the ligature being wrapped around the shaft but not the point. A fletched arrow shaft takes longer to manufacture than a chert arrow point and if it detached from the prey it could be recovered and reused by the hunter. Ethnohistoric descriptions of Iroquoian hunting indicate that men were absent from the village for long periods from the late fall to the winter solstice. Some women accompanied hunting parties to carry the meat back to the village. The points and point fragments found on Eaton are abundant in refuse areas and within houses, suggesting they were discarded after having been brought back to the village in meat, rather than being evidence of an enemy attack (Engelbrecht 2014a).

A total of 102 point bases and tips were refit and one triple match was made between a point base, a mid-section, and a tip. A mid-section and tip formed a refit, as did 10 mid-sections with 10 bases. Thus, a total of 103 points were completely reconstructed and 11 were partially reconstructed. The one triple refit and the 11 partial refits indicate that 12 (10.5 perecent) of the 114 refits represent points broken in three or more pieces. A 10-power hand lens was used to check each point mend for continuation of flake scars and other distinguishing characteristics. A separate study considering the distribution of these conjoined pieces expanding on an earlier study by Salisbury (2001) is currently being undertaken.

If the point fragments at Eaton consisted predominately of point bases, it could be argued that they were discarded after retooling the arrow shaft. Flenniken (1991) noted this pattern at a butchering

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camp in Oregon, and Knecht (1997a:8-9) cites other examples. However, the large number of both point tips and bases recovered at Eaton argues against this explanation.

Bifaces and biface fragments not showing use were classified following a modification of Callahan's (1979) biface reduction sequence (Stage 2, 2.5, 3, 3.5, and late stage). Bifaces classified as Madison points or Madison point fragments were thin with numerous flake scars on both faces. None were unifacial, and only one out of the 103 refits had only a few flakes removed on one face. Only 3 percent of whole points and 4 percent of the 808 bases were largely unifacial and even these specimens exhibited some bifacial flaking. Eighty-six percent of the 808 basal fragments exhibited clear use wear or grinding. This high percentage, as well as the near ubiquity of bifacial flaking, argues against most fragments in this study having been broken during the manufacturing process.

An unknown number of points may have been broken by accident, by impact on the site, by use as a tool other than a projectile, or by a post-depositional process such as plowing. The majority of artifacts at Eaton were recovered from the plow zone and the ratios of point tips, bases, and whole points found within and below the plow zone are broadly similar (subsoil: plowzone = tips 1:8.8; bases 1:9.6; whole points 1:7.4). Since the site was surface collected for over 100 years, the smaller proportion of whole points in the plowzone is likely due to removal by collectors (Engelbrecht 2014a:360).

Whole Points and Point Mends

Both whole points and refits are made from a similar spectrum of material. Ninety-two percent of both whole points and conjoined fragments were made of Onondaga chert. Fifteen whole points (3 percent) and four point refits (4 percent) were of Reynales chert. Twenty-two whole points (4 percent) and four refits (4 percent) were of Lockport chert. Four whole points were of Huronian chert (1 percent) but there were no refits of Huronian chert.

Many whole points and point fragments exhibit minor damage. Often a small portion of the tip is missing as a result of an impact fracture, or there is a damaged basal corner. While only specimens complete enough to measure maximum length, width, and thickness within a millimeter or two, and weight within 1-2 tenths of a gram are included, the measurements used in this study should be considered best estimates.

The range and mean for length, width, thickness, and weight for whole points and refits are given in Table 1. There were 808 point bases that were not refits. Of these, the width of the base could be measured on 768. They ranged from 9 mm to 28 mm in width. The average width was 15.9 mm, greater than that of either the refits (15.7 mm) or of the whole points (15.1 mm).

T-tests show significant differences between the lengths, widths, thicknesses, and weights of whole points and refits (Table 1). While there is considerable overlap between metric attributes of whole and refit Madison points from Eaton, on average the refit points are longer, wider, thinner, and heavier than whole points.

Discussion

In general, the refits are more fragile. On reflection this is not surprising, but the possibility that whole points have design characteristics rendering them more durable than broken points is rarely considered. First, the whole points have greater length:width ratios than the refits (1:85 for 516 whole points versus 2:1 for 103 refit points), rendering the refits more breakable. The different length:width ratios for whole and refit points from

Table 1. Comparison of Whole Points and Point Mends.

	Whole Points	Refits	*t*-Test (one)
Length (mm)	$N = 516$	$N = 103$	
Range	16-46	21-45	
Mean	27.4	33.3	$P > .001$
Width (mm)	$N = 516$	$N = 113$	
Range	9-28	11-22	
Mean	15.1	15.7	$P = .009$
Thickness (mm)	$N = 516$	$N = 113$	
Range	2-8	2-6	
Mean	4.2	3.7	$P > .001$
Weight (grams)	$N = 516$	$N = 103$	
Range	.4-4.6	.8-4.4	
Mean	1.6	1.9	$P > .001$

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Eaton agree with experiments performed by Odell and Cowan (1986) which suggest that points with lower length to width ratios are more durable. Not only is the point refit length:width ratio of 2:1 for refits greater than that of the whole points from Eaton, this ratio is greater than that for any of the 12 eastern Iroquois sites reported by Kuhn (1996).

A low thickness to length ratio provides an additional reason for the more breakable nature of the refits. The thickness to length ratio for the 516 whole points was .155 while the ratio for the 103 point refits was .115. Cheshier and Kelly (2006) found that points with a high thickness:length ratios (>.121) were less likely to break than those with a lower ratio. A comparison of whole points and point refits supports the experimental results of Odell and Cowan (1986) and Cheshier and Kelly (2006). Incidentally, an increasing number of bow hunters are now using stone tipped arrows and a study of these might provide further support (Scheck 2011).

Selection for Arrow Point Design Characteristics

Deer Hunting

Deer are the most common mammal remains identified at Eaton (Pipes 2009) and most other Iroquoian village sites (Kuhn and Funk 2000; Socci 1995:107). Shots most likely to drop a deer are those that penetrate the lung, causing hemorrhaging. Shots that penetrate the thoracic cavity are likely to cause a deer to collapse in about 10 seconds and the deer is unlikely to travel more than 45 m in that time (Friss-Hansen 1990:494-495). For bow hunters, the best shot is taken when the deer is broadside or quartering away.

A problem for the hunter is that the thoracic cavity lies within the rib cage. The distance between ribs on a deer depend on its age and sex, but for an adult deer, the ribs would be roughly between 2.5 cm and 5 cm apart. If arrow shafts were fletched causing spin, the orientation of the point as it entered the animal could not be controlled. Assuming 1.5 cm is the average width for Madison point bases and 3 cm is the average width for Levanna point bases, in flight the spinning bases would describe circles of 1.5 cm and 3 cm in diameter, respectively. Wider Levanna points would have more difficulty passing through the ribs, especially if the point entered with the base perpendicular to the ribs. A point with a narrow base has a greater likelihood of passing between the ribs of a deer or a human, though the latter have more closely set ribs, rendering this less likely.

Guthrie (1983:284) performed experiments with bone points on a dead moose and found that points under 1 cm or 1.1 cm in thickness more often passed between the ribs and penetrated the thorax than did thicker bone points. While thin bone points have an advantage in penetration, wider stone points have an advantage in cutting (Wilkens et al. 2014). The stone points should also be wide enough to create a wound that prevents drag on the shaft (Friis-Hansen 1990:495,498; Frison 1978:338). Thus, a stone point must be wide enough to cut the arrow shaft free and to cut enough blood vessels to cause massive hemorrhaging, but not so wide that it frequently hits the ribs.

The width of the vast majority of point bases at Eaton falls between 1.1 cm and 2 cm. Given the importance of deer as a prey species, the desirability of having a point penetrate the thoracic region, and the close set ribs shielding this region, the advantage of using a point between 1.1 cm and 2 cm is clear. This suggestion is supported by the fact that 28.7 percent of whole points (N = 516), 22.9 percent of refits (N = 113), and 30.8 percent of point bases (N = 806) had one or both basal corners either damaged or broken (see Figure 2). This damage pattern is consistent with the widest part of a triangular point grazing a deer rib. On average, broken points were wider than points that stayed intact.

Warfare

Both ethnographic observations and experimental studies indicate that stone projectiles have relatively short use lives, whether they are spear, dart, or arrow points (Ellis 1997:57; Fisher et al. 1984; Knecht 1997b:202-204). Many stone points break after the first shot and most break after two or three shots (Cheshier and Kelly 2006:354; Fauvell et al. 2012; Odell and Cowan 1986; Titmus and Woods 2006:43). Durability of points is seen as a positive attribute with the focus typically on hunting rather than killing enemies. However, arrow points made for warfare were made to be used

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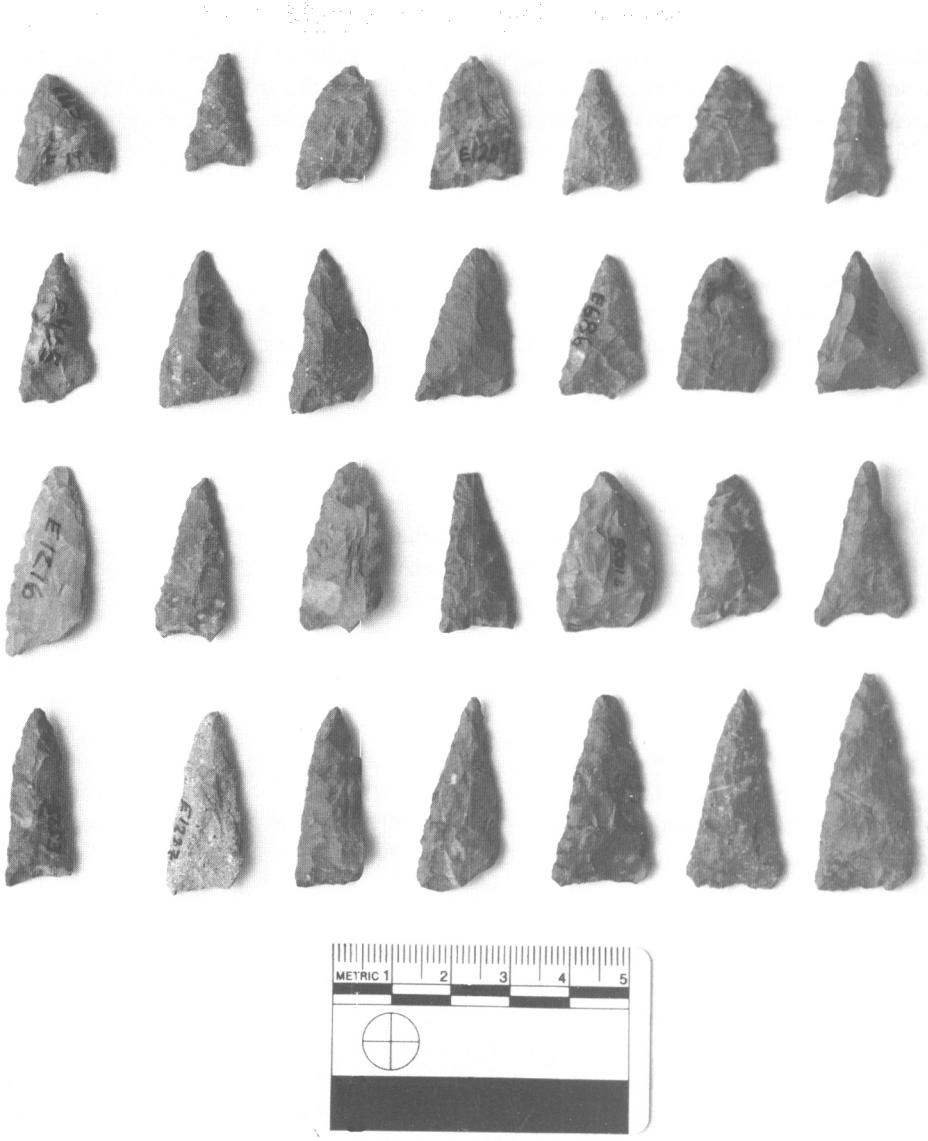


Figure 2. Points with damage to a basal corner (see lower right of each point). Identification numbers relate to specimens listed in the Madison Point Table (Engelbrecht 2015a). First row (left to right): 85, 364, 183, 2, 163, 408, 440. Second row (left to right): 379, 283, 365, 391, 490, 502, 494. Third row (left to right): 1, 106, 139, 178, 212, 261. Fourth row (left to right): 477, 311, 216, 254, 159, 457, 57.

once. A stone arrow point that struck an enemy would not likely be retrieved. In warfare, there was a clear advantage to using an arrow point that detached and shattered within the enemy, analogous to a modern fragmentation bullet. Projectiles that fragment cause a larger wound cavity and have more killing power than projectiles designed for maximum penetration (Wilkens et al. 2014:3). Fragments of a point left in a victim serve to increase the lethality or debilitating nature of the wound (Nelson 1997:378). It did not matter if an enemy died later from infection rather than immediately after being shot, as the desired result was the same.

Milner (2005:151) cites a U.S. army surgeon regarding the difficulty of extracting arrow point

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fragments from nineteenth-century soldiers. Stone arrows "were liable to break either when the arrow entered the body or shortly thereafter when the shaft was yanked and twisted when removing it" (Milner 2005:148). In an experiment with live feral goats, Flenniken (1985:270) found that the movement of the animal was sufficient to fracture stone spear points. These fragments traveled within the animal's body, raising the possibility of the same phenomenon in humans.

Archaeological examples of triangular point fragments associated with skeletons include the Buffalo site in West Virginia (late seventeenth century) where an adult skeleton was found with nine non-local triangular points. An illustration in Hanson 1975 suggests that five of these points had lost a portion of the tip (Figure 27). At Norris Farms #36 Cemetery, a triangular point (presumably Madison) along with numerous point fragments were found in bone (Milner et al. 1991:583; Ryan and Milner 2006:876).

Conclusion

While all stone projectile points have a relatively short use life as projectiles, it should not be a surprise that points with a greater length to width ratio or a low thickness to length ratio are less durable. This calls into question the representativeness of existing point typologies. Those formulating a normative description of a point type (average width, length, etc.) need to consider the possibility that the whole points on which the type description is based may not accurately reflect the entire population of specimens, the majority of which may be broken.

The shift from Levanna to Madison points involved a switch to narrower, thinner, and lighter points. Long, thin, narrow, unnotched triangular arrow points combine performance characteristics useful for both hunting and warfare. The desire for increased efficiency in killing both deer and enemies with the same type of projectile point likely drove the evolution of arrow point design.

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Data Availability Statement. Tables containing the distribution of points and point fragments and observations on individual points, refits, and point bases along with measurements of these artifacts are available in The Eaton Site Project (Engelbrecht 2014b, 2015a, 2015b, and 2015c) and on the Digital Archaeological Record (http://core.tdar.org/project/6030/eaton-site). The artifacts are curated in the Department of Anthropology, SUNY Buffalo State, 1300 Elmwood Ave., Buffalo, NY 14222.

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